ERGONOMIC STRINGED INSTRUMENT

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of PPA 60/411,276, filed 2002 Sep 17 by the present inventor.

BACKGROUND – Field of Invention

The present invention relates to a stringed musical instrument - having a support - that facilitates playing in a more ergonomic manner than known stringed musical instruments, thereby improving the musician's comfort and ease in playing the instrument.

BACKGROUND – Discussion of Prior Art

With greater understanding of human biomechanics, musicians strive to make their playing more ergonomic; comfort and ease of playing are ever more important in achieving better results. Any improvement of the interface between the musical instrument and the human body must be achieved without violating principles of human biomechanics (i.e., without imposing unnatural body positions, motions, or restrictions).

The dimensions of the instruments of the violin family (violin, viola, cello, and bass) are dictated by acoustical requirements of the strings and the appropriate resonating body; lower pitched instruments require longer strings and a larger resonance body. Built to meet the resulting structural requirements, these instruments are not designed for the comfort and ease of use of the musician. Further, many years of tradition have resulted in instrument makers doing little to improve the interface between instrument and musician; it is the musicians who are constantly advancing the playing technique to achieve greater comfort and ease while playing. Victor Sazer's Book, "New Directions in Cello Playing: How to Make Cello Playing Easier and Play Without Pain," is an example of an attempt to improve the playing technique in order to compensate for (not remedy) the known problems of said interface.

The cello has several unfavorable structural features that hinder the playing of the instrument. Cellists are known to have a high incidence of back pain and carpal tunnel syndrome, and in 1992 the Juilliard School of Music established an on-campus staff of physical therapists to treat performance-related injuries.

Although cellos can be built to fit a specific person, most are built for the non-existent "average person"; i.e., in a size and shape that is a compromise for every musician. Further, even though cellos can be made in different sizes, the proportions of the component parts remain the same such that some of the problems caused by the size and shape of the cello are not addressed.

For instance, although the height and angle (relative to the human body) of the instrument can be adjusted by changing the length of the protruding endpin section, the adjustment must still find a compromise between the comfort of the musician's right and left hands, legs and chest, and the position of the instrument's head relative to the musician's head.

Another problem is the biased orientation of the cello (as well as other string instruments) in favor of either the left arm's comfort or the right arm's comfort; i.e., the cello is tilted either toward the left side, allowing a more ergonomic range of motion for the musician's left arm, or toward the right side, allowing a more ergonomic range of motion for the right arm. U.S. patents 4,534,260 to Burrell (1985) and 6,034,308 to Little (2000) propose a fingerboard structure having a twist along its longitudinal axis to allow more ergonomic motion for both the musician's arms; this approach offers a solution for only part of the fingerboard and it requires elaborate construction.

Further, the cello's longitudinal axis and the longitudinal axis of the instrument's fingerboard can not be positioned on the anatomical median plane of the musician's body, often resulting in a twisted spine, a locked left elbow and string crossings that can not be accomplished in an ergonomic manner. While the instrument's longitudinal axis is usually not identical to the longitudinal axis of the instrument's fingerboard, the playing position and symmetry of a cello imply that the longitudinal axis of the fingerboard can be positioned on the anatomical median plane of the musician's body only if the instrument's longitudinal axis is positioned on said plane.

Other problems with the left hand are well known to instructors and musicians alike. These problems include the unnaturally high position of the left hand in known "lower" positions, the fact that a student does not get visual feedback while playing in these positions, as well as the unnaturally wide spread of the left hand in said positions, requiring constant adjustment of the now non-equidistant finger spread (the human hand has an equidistant finger spread when kept in its natural spread width).

The misalignment of the cello's pivot point (on the floor) and the musician's pivot axis when swaying the upper body from side to side (at about sitting level) changes the position of the cello relative to the musician's body; thus a musician is forced to choose either to not sway or to develop a technique that adjusts to this always changing

interface. Supporting the cello without the use of an endpin - musicians specializing in baroque music often use period instruments without endpins - gives the musician the freedom to move while maintaining the instrument's position relative to position of the human body. However, supporting the instrument's weight with the legs is quite tiresome, the reason why most modern cellists prefer to use an endpin.

The interface between floor and endpin (ball joint type) enables the cello to rotate around its longitudinal axis; the musician must thus constantly maintain the cello's stability by using the legs, chest, and sometimes the left hand. The points of contact (bow-string interfaces) are not located on the instrument's longitudinal axis, causing bow movement to induce disturbance of the instrument's rotational stability.

The use of an endpin is problematic for other reasons as well. The interface between the floor and the endpin must provide enough friction to prevent the endpin from slipping, while the floor surface must be protected. There are many known devices related to this problem; for instance, U.S. patent 4,370,911 to Goldner (1983) shows a pointless endpin attachment for the cello. Although this support appears to prevent rotation of the instrument around its longitudinal axis, the surface area of attachment contacting the floor is in fact too small to prevent the described rotation. An example of a widely used nonstop endpin holder is shown in U.S. patent 5,696,338 to Grissom (1997). This device allows the endpin to pivot freely, but permits the undesired rotation around the instrument's longitudinal axis.

Cellos are played in positions that range from vertical to almost horizontal. While the endpin supports most of the instrument's weight in a vertical playing position, the musician has to support more of that weight when approaching a horizontal playing position, because the instrument's center of gravity is not directly supported by the endpin. U.S. patent 4,586,418 to Stahlhammer (1986) claims a bent endpin structure, thereby moving the interface between endpin and floor to better support the instrument's

center of gravity. While this device reduces the effective weight of the instrument bearing on the musician, the distance between the instrument's rotational pivot axis (defined by the endpin's interface with floor and the instrument's interface with the musician at the chest) and the point of contact (the interface between bow and string) is increased, causing bow movement to induce more disturbance to the instrument's rotational stability. U.S. patent 5,297,771 to Gilbert (1994) discloses a similar device for the double bass.

A better way of supporting the instrument would be to elevate it by a stationary support, thus moving the instrument's pivot point to just under the instrument, as illustrated in a portrait (c. 1690) painted by Constantin Netscher; shown is a bass viol player standing with the viol supported on a small stool. This approach still fails to prevent the instrument's rotation around its longitudinal axis.

U.S. Patent 2,814,229 to Vaccaro (1957) discloses a musical instrument support that is intended to facilitate playing the violin or viola "positioned astride the thighs" supporting the instrument on the lap with the scroll resting against the neck. Rotation of the instrument around its longitudinal axis remains problematic, as now the player has to use his/her left hand to stabilize the instrument. In addition, this support is not very stable, being based on the player's legs.

U.S. Patent 5,789,677 to Johnson (1998) shows a chair-based instrument support, used for a tuba, freeing the musician's legs from having to support such a heavy instrument. This support is not useful for string players, because it allows the stringed instrument to rotate around its longitudinal axis, thereby restricting the musician's freedom of motion by forcing him/her to stabilize the instrument.

Bassoon players often support their instrument at about seat height using a strap that is tucked under the seat. This free pivoting support works well for the bassoon; rotation around its longitudinal axis is easily controlled by the player's hands.

Another problem of playing a bowed string instrument is the misalignment of known "points of contact". The point of contact describes the ideal point of interface between the bow and the string, all other parameters (bow speed and bow pressure) being constant; the point of contact is different for each string (distance from bridge greater for lower pitched strings). The player must constantly compensate for this misalignment by either adjusting the bow to agree with the point of contact or changing other parameters (such as bow speed and bow pressure) in order to change the point of contact.

The fingerboard topology of string instruments (the arrangement of finger placements on the fingerboard) is determined by the orientation of the nut and the bridge, traditionally being perpendicular to the longitudinal axis of the fingerboard (guitar frets are parallel to the bridge). The natural direction/orientation of the musician's fingers, however, is different for each playing position; especially when playing barred chords, the hand's orientation needs to be adjusted to correspond with the fingerboard topology.

Similar problems are found with other members of the violin family. The violin (or viola) is entirely supported by the musician, thus offering the advantage of moving congruently with the musician's torso. Held between the musician's shoulder and chin, the violin's position - as well as left hand playing technique - is known for its non-ergonomic nature.

While there are many chin and shoulder rests claiming to improve comfort of the musician, only the following two approaches seem to adequately address the problem. U.S. patent Des. 338,222 to Steinberger (1993) shows an electric violin with just the essential features, thereby reducing the weight of the instrument. U.S. patent 5,780,756 to

Babb (1998) introduces a new support system utilizing the musician's shoulder and neck but not the chin.

Plucked string instruments also have some of the same disadvantages and limitations. The orientation of the guitar, in particular the fingerboard, often causes problems for the left arm; guitar players who play their instrument in an almost horizontal position have discovered that this position induces considerable stress on the musician's left wrist, resulting in some of the same types of chronic injury as listed above.

An often overlooked problem is the overuse of the left hand's thumb which is used to apply counter pressure for all other playing fingers. For this reason, some guitar players have begun playing their instruments in a position similar to that of a cellist, sometimes even supporting them with an endpin.

The development of the electric pickup provided an opportunity to address some of these ergonomic shortcomings; its ability to amplify the natural volume of an instrument or to even replace the resonating body altogether changes the paradigm of instrument construction.

However, as far as is known, the approach used by the electric string instrument makers has been to imitate both the features and structural dimensions of the acoustic counterpart to make the transition from acoustic to electric an easy one; despite some ergonomic improvements over their acoustic counterparts, most electric instruments imitate the "feel" of the acoustic instrument. U.S. patents Des. 419,587 to Okamura (2000), and 6,255,565 (2001), 6,414,234 (2002), both to Tamura, show electric instruments with almost traditional instrument body outlines in form of permanent, foldable, or detachable (for storage only) structures, thus still hindering playing comfort.

Innovative electric cello designs by makers such as Jensen and Steinberger have omitted much of the traditional body outline; they do, however, include knee braces, endpin, and chest support, thus still maintaining the playing posture of the acoustic counterpart.

There are some bowed string instruments that are played in positions different from those of the violin family.

The chianuri, or two-string bowed lute, is played with the body of the instrument resting between the musician's legs, but the head of the instrument rests against the shoulder such that the instrument is not positioned on the musician's median plane.

Kirghiz musicians play a two-string fiddle, the kiak, and musicians in the Rajasthan area of Northern India play two bowed lutes, the sindhi-sarangi and gujrati-sarangi, in much the same way.

The kemençe, a three-string bowed lute found on the eastern coast of the Black Sea, rests on the player's thigh and leans back against the shoulder, and therefore is <u>not</u> positioned on the player's median plane.

A number of so-called spike fiddles are known, including the Kemane spike fiddle, the esraj, diluba, saringda, chikara, ghichak (Tajikstan), k'amanch'a (Armenia), juza (Iraq), kemanche (Northern India and Azerbaijan), gheichek, or short-necked fiddle (Baluchistan), and rêbab (Java). Spike fiddles are generally held upright on the knee, leaning back against the chest, or with the musician seated cross-legged and the scroll balanced against the upturned right foot and the other end of the instrument under the chin. Like the other instruments listed, they are not positioned on the median plane of the musician's body and therefore do not address many of the disadvantages and limitations described above.

Each instrument of the violin family has a different playing technique; while playing the violin is similar to playing the viola, the cello technique is quite different from that for violin. Most school orchestra teachers are currently teaching all (bowed) string instruments at the same time; having a universal technique for all string instruments would certainly improve the situation. Attempts have been made to develop such string instruments that are alternatives to the instruments of the violin family: U.S. patent 3,969,971 to Delu (1976) introduces the VIODES system, a family of bowed string instruments of identical overall length, in particular string length, but in graduated widths and depths. While all these instruments can be played using the same technique, they do not offer any ergonomic advantages.

The members of the violin family, being non-fretted string instruments, offer a great advantage over their fretted ancestors by providing total freedom of pitch control for achieving better intonation. This obvious advantage, however, is accompanied by a major drawback: until a musician has mastered the skills of utilizing this freedom of pitch control, poor intonation is a great obstacle to an enjoyable musical experience. Most school orchestra programs suffer from this dilemma, losing numerous students to the band program. While a fretted fingerboard would provide temporary relief, students would eventually have to retrofit their instruments with non-fretted boards once they have achieved sufficient mastery.

OBJECTS AND ADVANTAGES

Accordingly, several objects and advantages of the presentation invention are:

to provide a stringed musical instrument that is comfortable and easy to play, thereby improving playing, teaching, and learning;

to provide a stringed musical instrument that can be played having both hands in front of the torso, thereby facilitating ergonomic movement and improving the comfort and ease of playing;

to provide a stringed musical instrument that can be played having the longitudinal axis of the fingerboard aligned with the musician's anatomical median plane, thereby facilitating ergonomic movement and improving the comfort and ease of playing;

to provide a stringed musical instrument that facilitates left hand operation below shoulder level, thereby improving the left arm's playing comfort;

to provide a stringed musical instrument having a string length that enables the use of an ergonomic finger spread for the widest hand positions (close to the nut), thereby improving comfort and ease of playing for the left hand;

to provide a stringed musical instrument having a string length that enables ergonomic positioning of the entire instrument in front of the musician's body;

to provide a stringed musical instrument having a string configuration that substantially aligns the points of contact (bow-string interface), compensating for the different parameters of each string, thereby improving the ease of string crossings for the right (bow) arm, wrist, hand, and fingers;

to provide a stringed musical instrument that can be fitted with different string configurations, thereby creating a family of instruments that cover a wide range of tonal registers and can be played using a universal technique;

to provide a stringed musical instrument that enables visibility of the entire fingerboard while maintaining an ergonomic playing position, thereby facilitating the use of visual fingerboard guides;

to provide a stringed musical instrument of small overall dimensions, thereby improving storage and transportation of the instrument;

to provide a stringed musical instrument of simple design;

to provide a stringed musical instrument able to interchange its fingerboard;

to provide a stringed musical instrument of durable construction;

to provide a stringed musical instrument having both ends of the fingerboard supported, thus providing stationary stability relative to the musician;

to provide a stationary instrument support system that reduces the effective weight of the instrument bearing on the musician, thereby improving comfort and freedom of movement;

to provide a stationary instrument support system that enables instrument movement congruent with any movement of the musician's torso;

to provide a stationary instrument support system that prevents rotation of the instrument around its longitudinal axis, freeing the musician from having to prevent such rotation, thereby improving comfort and freedom of movement;

to provide a musical instrument having an ergonomic fingerboard topology; i.e., having a system of frets (physical or imaginary) aligned with the natural direction of the musician's left hand, thereby improving comfort and ease in particular for the musician's left wrist; and

to provide a stringed musical instrument having a more intuitive tuning system.

Further objects and advantages will be made clear by the following description and drawings.

SUMMARY

These objects are achieved by providing a stringed musical instrument having a stationary support; one part of the instrument interfacing with the musician's sternum, another part interfacing with the support, the longitudinal axis of the instrument aligned with the musician's anatomical median plane; the support enabling congruent movement between the instrument and the musician's swaying torso while preventing rotation of the instrument around its longitudinal axis; the instrument has an effective string length less than that of a cello and more than that of a viola for ergonomic positioning of both left arm and bow arm operations, the instrument further having a non-traditional bridge-nut configuration for a more ergonomic fingerboard topology and alignment of known points of contact; further a modular fingerboard for both convenient interchange of either instrument or fingerboard and for simplified assembly; further a geared tuning system having tuning wheel for more intuitive tuning by sliding a finger tangentially along the wheel.

BRIEF DESCRIPTION OF DRAWINGS

In the drawings, closely related figures have the same number but different alphabetic suffixes.

Figs. 1A to 1C show different views of an embodiment of a musical instrument, constructed in accordance with the teachings of the present invention.

Figs. 2A and 2B show two views of a machine tuner used with the instrument of Fig. 1A.

Fig. 3 shows the position of the tuners (of the type shown in Fig. 2A) within the assembly of the instrument of Fig. 1C.

Figs. 4A and 4B show two partial views detailing the top part of the instrument of Fig. 1A.

Figs. 5A to 5C show different views of a support system (having a gimbal) constructed in accordance with the teachings of the present invention.

Fig. 6 shows the musical instrument of Fig. 1A interfacing with the support of Fig. 5B.

Fig. 7 illustrates the anatomical planes of a human body.

Fig. 8 shows the instrument of Fig. 1A being played by a musician.

Figs. 9A and 9B show two views of an attachment used with the instrument of Fig. 1A.

Fig. 10 illustrates the interface between the musician's left hand and the instrument of Fig. 1A, as well as the interface between a bow and the instrument.

Figs. 11A to 11C show members of the violin family.

Figs. 12A and 12B show two embodiments of a guitar.

Fig. 13 shows a traditional support used with the instrument of Fig. 1A.

Fig. 14 shows an alternative embodiment of the support of Fig. 5A constructed in accordance with the teachings of the present invention.

Fig. 15 shows an acoustic embodiment of the invention constructed in accordance with the teachings of the present invention.

Fig. 16 shows a traditional electric cello used with the support of Fig. 5A.

Fig. 17 shows a keyboard used with the support of Fig. 5A.

Fig. 18 shows a wind instrument used with the support of Fig. 5A.

Figs. 19 to 21 show the instrument of Fig. 1A used with alternative embodiments of the support of Fig. 5A.

Fig. 22 shows an alternative embodiment of the support of Fig. 5A used with a traditional music stand.

Fig. 23 shows an alternative, highly portable embodiment of the support of Fig. 5A.

Figs. 24 to 25 show the support of Fig. 5A used with the seat of a stool.

Figs. 26 to 29 show alternative embodiments of the support of Fig. 5A used with the seat of a stool.

Figs. 30A to 30C show different views of a simplified instrument-support unit, constructed in accordance with the teachings of the present invention.

Figs. 31A to 31C show different views of an alternative embodiment of the instrument of Fig. 1A.

Figs. 32A and 32B show different views of an insert for use with the instrument of Fig. 31A.

Figs. 33A to 33D illustrate the assembly of the instrument of Fig. 31A.

Figs. 34A and 34B show an alternative embodiment of the support of Fig. 5A used with the instrument of Fig. 31A.

Figs. 35A and 35B show an alternative embodiment of the support of Fig. 5A used with an alternative embodiment of the instrument of Fig. 31A.

Fig. 36 shows the instrument of Fig. 31A being played by a seated musician using the support of Fig. 34A.

Fig. 37 shows the instrument of Fig. 31A being played by a standing musician.

REFERENCE NUMBERS IN DRAWINGS

10	instrument
12	body of instrument 10
14	first end of body 12
16	second end of body 12
18	strings of instrument 10
20	fingerboard of instrument 10
22	nut of instrument 10
24	bridge of instrument 10
26	tuning peg of tuner 46
28	tuning knob of tuner 46
30	cover plate of instrument 10
31	visual guide on cover plate 30
32	screws of cover plate 30
34	cable of instrument 10
36	jack of instrument 10
38	protrusion at first end 14
40	ridge at second end 16
42	screw of tuner 46
44	washers of tuner 46
46	tuner of instrument 10
48	drive shaft of tuner 46
50	cavity at first end 14
52	tunnel at first end 14
54	tunnel entrances of tunnel 52
56	tunnel exits of tunnel 52
58	gimbal system of support 60

60	support
62	support member of support 60
64	oval hole of support member 62
66	outer ring of gimbal system 58
68	median ring of gimbal system 58
70	inner ring of gimbal system 58
72	oval periphery of outer ring 66
74	inner surface shape of hole 64
76	pins to connect rings 66-70
78	bores in outer ring 66
80	bores in median ring 68
82	bores in median ring 68
84	bores in inner ring 70
86	inner surface shape of inner ring 70
88	pivot axis of median ring 68 (longitudinal axis of support member 62)
90	pivot axis of inner ring 70
92	longitudinal axis of instrument 10
94	human body
96	median plane of human body 94
98	coronal plane of human body 94
100	horizontal plane of human body 94
102	musician
104	chair
106	bow
108	attachment for first end 14
110	hand, approaching nut
112	hand, approaching bridge
114	orientation of bridge 24

116	orientation of nut 22
118	longitudinal axis of fingerboard 20
120	points of contact between bow 106 and strings 18
122	violin/viola
124	cello
126	double bass
128	bridge of violin 122
130	bridge of cello 124
132	bridge of double bass 126
134	nut of violin 122
136	nut of cello 124
138	nut of double bass 126
140	guitar, classical
142	guitar, non-classical
144	nut of guitar 140
146	nut of guitar 142
148	bridge of guitar 140
150	bridge of guitar 142
152	endpin structure
154	tripod with gimbal system 58
156	acoustic embodiment of instrument 10
158	second end of body 162
160	first end of body 162
162	body of acoustic embodiment 156
164	electric cello
166	first end of body 172
168	second end of body 172
170	chest rest of body 172

172	body of electric cello 164
174	keyboard
176	first end of body 178
178	body of keyboard 174
180	second end of body 178
182	wind instrument
184	first end of wind instrument 182
186	body of wind instrument 182
188	second end of wind instrument 182
190	first alternative support
192	support member of support 190
194	living hinge
196	first axis of living hinge 194
198	second axis of support member 192
200	second alternative support
202	support member of support 200
204	universal joint of support 200
206	first axis of universal joint 204
208	second axis of universal joint 204
210	third alternative support
212	support rods (two) of support 210
214	bores of seat 216
216	seat
218	end points of support rods 212
220	first axis of support 210
222	second axis of support 210
224	fourth alternative support
226	music stand

228	support member of support 224
230	mounting system of support 224
232	fifth alternative support
234	base of fifth alternative support 232
236	slot in seat 216
238	first mount of seat 216
240	sixth alternative support
242	telescopic support member of support 240
244	seventh alternative support
246	curved support member of support 244
248	second mount of seat 216
250	eighth alternative support
252	support member of support 250
254	pin of support member 252
256	modified gimbal system
258	ninth alternative support
260	two-segment support system of support 258
262	hinge of support 258
264	simplified instrument-support unit
266	simplified instrument
268	simplified support
270	hinge for simplified instrument support unit 264
272	strings for unit 264
274	fretted fingerboard of instrument 266
276	child
278	alternative embodiment of instrument 10
280	body of instrument 278
282	fingerboard of instrument 278

284	insert of instrument 278
286	economized head design of instrument 278
288	bass guitar tuners of instrument 278
290	cavity of instrument 278
292	slot for receiving bridge 24 of instrument 278
294	set of four holes of instrument 278
296	potentiometer of instrument 278
298	cavity of insert 284
300	support of instrument 278
302	thin disc magnets of instrument 278
304	cavity system of insert 284
306	thick disc magnets of insert 284
308	ball bearings of body 280
310	mini disc magnets of body 280
312	hemispherical recesses of fingerboard 282 and nut 22
314	support member of support 300
316	ferrous metal cylinder of support 300
318	longitudinal axis of cylinder 316
320	longitudinal axis of support member 314
322	support of instrument 278
324	living- hinge of support 322
326	tongue of living-hinge 324
328	groove of modified insert 330
330	modified insert of embodiment 278
332	axis of living hinge 324
334	longitudinal axis of instrument 278

DESCRIPTION – Preferred Embodiment I

Figs. 1A (front elevational view), 1B (side elevational view), and 1C (back elevational view) show an embodiment of a musical instrument **10** (generally indicated), constructed in accordance with the teachings of the present invention. Instrument **10** comprises an elongated body **12** having a first end **14** and a second end **16**. Strings **18** are suspended over a fingerboard **20** bound by a nut **22** and by a bridge **24** (the non-traditional orientation of bridge **24** is discussed in detail in Fig. 10); strings **18** are held in tension by anchoring at first end **14** of body **12** and winding each around a corresponding peg **26** located near second end **16** of body **12**. Pegs **26** are each connected to a corresponding tuning knob **28** that is recessed within body **12** of instrument **10** as shown in Fig. 1C. A cover plate **30** is mounted with three screws **32** at second end **16** of instrument **10** closing a concavity at the back side of body **12** necessary for the recessed integration of tuners (not numbered here, shown in more detail in Figs. 2A, 2B, and 3). Cover plate **30** has a visual guide **31** imprinted onto its surface indicating the relationship between sliding direction on tuning knob **28** and pitch direction, up or down. A cable **34** (shown in dashed lines) connects bridge **24** (bridge has integrated pickup system, available from R. Barbera in New York, NY) with a jack **36** (shown in dashed lines); jack **36** is mounted into a complementary-shaped bore in/at cover plate **30** (shown in more detail in Fig. 3). Bridge **24**, nut **22**, and strings **18** are protected by a protrusion **38** (shown in more detail in Figs. 4A and 4B) of body **12** at first end **14** and a ridge **40** at second end **16**; ridge **40** protrudes from body **12** beyond tuning pegs **26**, thereby enabling safer handling of instrument **10**. Ridge **40** further functions as a string guide redirecting strings **18** through holes (Fig. 1A, strings shown in dashed lines) in ridge **40** from bridge **24** to appropriate tuning pegs **26**.

First end **14** of body **12** is shaped so that it can comfortably rest against the sternum of a person playing instrument **10**; second end **16** of body **12** is tapered so that it can interface with a support (shown in detail in Figs. 5A to 5C).

Figs. 2A (exploded perspective view), 2B (perspective view), and Fig. 3 (partial perspective view) show the structure of a machine tuner **46**, including tuning peg **26** and tuning knob **28**, used with instrument **10**. The original tuning knob (not shown, part of a machine tuner available from Schaller, Germany) is replaced with tuning knob **28**, shaped like a wheel and provided with a knurled surface on outer rim to provide friction. Tuning knob **28** is mounted onto a drive shaft **48** using a screw **42** and washers **44**.

Fig. 3 shows cover plate **30**, screws **32**, and jack **36** (in dashed lines), as well as the integration of tuners **46** (shown partially in dashed lines; for clarity, number not shown) within body **12** of instrument **10**. While tuning knobs **28** are retracted far enough into body **12** to avoid accidental tuning, a portion of each knob **28** is easily accessible to a person playing instrument **10**; a string **18** can thus be tuned by sliding a finger tangentially along the outer rim of corresponding tuning knob **28** parallel to the longitudinal axis (not numbered here) of instrument **10**. For clarity, cable **34** is not shown. Visual guide **31** indicates the relationship between sliding direction and pitch direction.

Figs. 4A and 4B (both perspective partial views) show the front and back side of first end **14** of body **12** of instrument **10** in more detail. Strings **18** (here not shown for clarity) are anchored in a retracted area, cavity **50**, each passing through a corresponding tunnel **52** (shown in dashed lines under protrusion **38**) that extends from a tunnel entrance **54** inside cavity **50** to a tunnel exit **56** close to nut **22**. Tunnel entrances **54** are fitted with replaceable washers (not numbered) to prevent strings **18** from damaging body **12** of instrument **10**.

The entire first end **14** of body **12** is designed to enable an ergonomic interface between instrument **10** and a person playing instrument **10**, specifically between first end **14** and the sternum of the person: the surface surrounding first end **14**, especially the back side and area framing cavity **50**, is smooth and rounded; and strings **18** are retracted within

cavity **50** far enough to prevent any interference with the interface between instrument **10** and the person playing instrument **10**.

Figs. 5A (exploded perspective view), 5B (assembled perspective view), and 5C (perspective view) show a preferred embodiment of a support **60** for use with instrument **10**, support **60** comprising a support member **62** and a gimbal system **58** which comprises an outer ring **66**, median ring **68**, and inner ring **70** (the word "gimbal" is often used to refer to a single ring as well as to the assembly of two or more rings; to avoid confusion the word "gimbal" is used only in connection with the term "gimbal system", referring to a set of pivotally interacting rings). Support member **62** has a hole **64** at one end, shaped slightly elliptic for receiving gimbal system **58** (Fig. 5A). The outer ring **66** of gimbal system **58**, while having both a round upper rim and round inner surface shape, has a slightly elliptic periphery **72** corresponding to the inner surface shape **74** of hole **64**. Thus, outer ring **66** is a stationary ring; it connects gimbal system **58** with support member **62.** Basing the interface between gimbal system **58** and support member **62** on an elliptic (not round) shape in effect clearly defines such interface (the symmetry of gimbal system **58** allows two possible ways of interfacing, both indistinguishable).

Median ring **68** of gimbal system **58** is connected at bores **80** to outer ring **66** at bores **78** by pins **76**; bores **78** thus define a pivot axis **88** (Figs. 5B and 5C) for the rotation of median ring **68** relative to outer ring **66**. Pivot axis **88** , by design, is identical to the longitudinal axis (referred to with same number to avoid confusion) of support member **62**.

Inner ring **70** of gimbal system **58** is connected at bores **84** (only one bore visible) to median ring **68** at bores **82** by pins **76**; bores **82** thus define a pivot axis **90** (Figs. 5B and 5C) for the rotation of inner ring **70** relative to median ring **68**. The inner surface shape **86** of inner ring **70** (here shown slightly conical) is designed to correspond to the shape of second end **16** (not shown) of body **12** of instrument **10** (not shown). The inner

ring **70** can be fitted with a rubber grommet (option not shown) to improve the interface between instrument **10** and support **60**.

Fig. 5B shows support **60** with gimbal system **58** having both median ring **68** and inner ring **70** positioned within the plane of support **60**, thereby enabling convenient storage and transportation.

Fig. 5C shows support **60** with gimbal system **58,** median ring **68** and inner ring **70** in a position different from that shown in Fig. 5B. While inner ring **70** has two degrees of freedom (pivot axes **88** and **90**; orientation of axis **90** dependent on rotation around axis **88**) it can not rotate within its own plane.

DESCRIPTION – Operation

Fig. 6 (perspective view) shows instrument **10** and support **60**, second end **16** of body **12** of instrument **10** interfacing with gimbal system **58** of support **60**, specifically at inner ring **70**. There is a special degree of freedom regarding the interface between instrument **10** and support member **62** (stationary portion of support **60**): the orientation of instrument **10** - relative to its longitudinal axis **92** - is not defined prior to interfacing with support **60**, thereby enabling a musician to arrange his/her interface to personal preferences. Instrument **10** is retaining its position relative to inner ring **70** (of gimbal system **58**) due to (gravity-induced) friction between inner surface shape **86** (Figs. 5A to 5C) of inner ring **70** and second end **16** of body **12**. Thus, the degrees of freedom of instrument **10** relative to support member **62** are defined by the degrees of freedom of inner ring **70** relative to support **60** as described in Figs. 5A to 5C.

Rotation of instrument **10** around its longitudinal axis **92** is resisted, as long as axis **92** is not aligned with axis **88** (axes **92** and **88** identical); axis **92** is stabilized at first end **14** (interface with torso of a musician as shown in Fig. 8) and second end **16** (interface with inner ring **70**), second end **16** stable due to its very location (by design of instrument **10**) on said axis **88**. This described rotational stability is little effected by forces (plucking or bowing) applied to strings **18**, because strings **18** (by design of instrument **10**) are relatively close to the longitudinal axis **92** of instrument **10**.

Fig. 7 (perspective view) shows three imaginary planes that pass through the human body **94** in the anatomical position, which help to describe movements and body positions. These are the median plane **96**, coronal plane **98**, and horizontal plane **100**.

Median plane **96** is an imaginary vertical plane that passes through the middle of body **94**, dividing it into left and right halves. A sagittal plane is a vertical plane which runs parallel to median plane **96**, but does not necessarily pass through the body's midline. Thus, median plane **96** is a specific type of sagittal plane. Coronal plane **98** is a

vertical plane which is perpendicular to the median and sagittal planes, and is sometimes also referred to as the frontal plane. Horizontal plane **100**, or transverse plane, is a plane which splits the body into upper and lower halves.

It will be understood by those skilled in the art who have the benefit of this disclosure that the anatomical planes described herein are being defined relative to the torso of the human body **94**; in other words, the orientation of the anatomical planes is congruent with the orientation of the torso of the human body **94**.

Fig. 8 (perspective view) shows a musician **102** playing instrument **10**, instrument **10** interfacing at first end **14** with musician **102** at the sternum and at second end **16** with support **60** via gimbal system **58**. Support member **62** of support **60** is connected to the seat of a chair **104**. While support member **62** can be secured at chair **104** by a clamp (not shown) or other means, it can be held in place by musician **102** sitting on chair **104**. Support member **62** is thus stationary relative to chair **104**.

Support **60** is positioned having pivot axis **88** of median ring **68** (pivot axis **88** identical to longitudinal axis of support member **62**) positioned on the median plane of musician **102**. The interface between instrument **10** and support **60** is thereby positioned on the median plane of musician **102**; the interface between instrument **10** and musician **102** (at the sternum, located by definition on the median plane) is positioned on the median plane. Thus, instrument **10**, specifically longitudinal axis **92** of body **12** of instrument **10**, is now positioned on the median plane of musician **102**.

The position of support **60** relative to musician **102**, specifically the distance between gimbal system **58** and the seat of musician **102**, defines the position of instrument **10** relative to musician **102**, specifically the orientation of longitudinal axis **92** of instrument **10** and the precise location of the interface between first end **14** and musician **102** at the sternum. Pivot axis **90** facilitates the adjustment of the angle between longitudinal axis **92** of instrument **10** and longitudinal axis **88** of support member **62**.

Musician **102** can thus adjust the position of instrument **10** by adjusting the position of support **60**.

The symmetry of human body **94** (Fig. 7) relative to median plane **96** (Fig. 7) defines basic principles for ergonomic posture. The basic playing position of instrument **10** on the median plane of musician **102** enables such ergonomic posture, facilitating a natural position of the spine as well as near neutral positioning of wrist, hand and shoulder. Especially the left arm of musician **102** can operate in a natural position in front of the torso of musician **102** further preventing the left shoulder from operating in its end-range of rotation. The streamlined structure of body **12** of instrument **10**, especially the omission of additional body outlines imitating the structure of an acoustic instrument, enables the left hand of musician **102** to comfortably access the entire fingerboard **20**.

The described position of instrument **10** further facilitates ergonomic string crossings that can now be executed by rotating the entire arm-torso-system of musician **102** around an axis (ideally being the longitudinal axis of fingerboard **20**, close to longitudinal axis **92** of instrument **10**) located on the median plane of musician **102**.

Instrument **10**, when interfacing with support **60**, resists rotation around its longitudinal axis **92**; thus, it does not require musician **102** to stabilize instrument **10** by using legs or even the left hand, eliminating restrictions of the musician's mobility. In fact, instrument **10**, when interfacing with support **60**, interfaces with musician **102** at only one point, enabling maximum freedom of motion; further, this interface at the sternum of musician **102** is very comfortable, due to both the shape of first end **14** of body **12** and the low effective pressure applied to the sternum. The sternum is chosen as the point of interface between musician **102** and instrument **10** for several reasons: the sternum is located (by definition) on the median plane, enabling a position of instrument **10** that facilitates the discussed ergonomic advantages; the sternum, not covered by thick tissue, provides a firm base for a stable interface; and the sternum further provides reasonable stationary stability, little effected by any movement of the arms of musician **102**.

Unrestricted freedom of motion is certainly essential for proper playing technique, especially side-to-side swaying motion. When seated, this side-to-side motion is confined to the torso of musician **102**, the idealized pivot axis for this swaying motion of the torso being close to longitudinal axis **88** (identical to pivot axis of median ring **68**) of support member **62**, axis **88** located on the median plane of musician **102** and perpendicular to the coronal plane of musician **102**. Thus, gimbal system **58**, in particular pivot axis **88** of median ring **68**, enables instrument **10** to move congruently with the torso of musician **102**, when swaying side-to-side; instrument **10** retains its position relative to the torso of musician **102** (longitudinal axis of instrument **10** on the median plane of musician **102**) when said torso sways side-to-side. Clearly, the configuration of gimbal system **58** (axes perpendicular, axis **90** dependant on axis **88**) as well as its orientation, relative to the anatomical planes of musician **102**, is essential to the described operation; thus, a ball bearing pivoting system does not constitute a useful alternative.

While the position of pivot axis **88** is essential for instrument **10** to move congruently with the torso of musician **102**, there are alternatives to support **60** (chair-based) including gimbal system **58** (freedom of motion defined by two perpendicular pivot axes); a tripod (floor-based) having a universal joint (two perpendicular pivot axes) would be such an alternative. However, a chair-based support such as support **60** has several advantages: by definition, support **60** provides stationary stability relative to chair **104**, thereby securing the position of the interface (between instrument **10** and support **60**) relative to musician **102** sitting on chair **104**; support **60** further provides convenience when used with a height-adjustable seat, again retaining the position of said interface (between instrument **10** and support **60**) relative to musician **102**; and support **60** facilitates the use of a swivel chair, an option that is not practical when using an endpin-support (floor-based) cello.

The affinity in size and shape between instrument **10**, support **60**, and bow **106** allows for easy storage and transportation.

The length of body **12** and the position of both nut **22** at first end **14** and bridge **24** at second end **16** enable an ergonomic playing posture and playing technique for both left hand and right arm operations. The effective string length, defined as distance between nut **22** and bridge **24**, is larger than that of a traditional viola and smaller than that of a traditional cello.

Figs. 9A (perspective view) and 9B (enlarged view) show a preferred embodiment of an optional attachment **108** for use with the first end **14** of body **12** of instrument **10**. Attachment **108** has the structure of a ball having a cut-out, shaped to complement the shape of first end **14**; attachment **108** connects to the back side of first end **14** by friction fit.

Attachment **108** adds several features to the functionality of the interface between musician **102** and instrument **10**: attachment **108** provides a wider surface area for comfortably contacting with the sternum of musician **102**; attachment **108** increases the distance between instrument **10** and the sternum of musician **102**, changing the position of the interface between the left hand of musician **102** and instrument **10** to a preferred position; attachment **108** covers cavity **50** (Figs. 4A and 4B) at first end **14**, preventing any interference of strings **18** (anchored within cavity **50**) with fibers (entering cavity **50**) of garment worn by musician **102**; and attachment **108** further protects both instrument **10** (at first end **14** of body **12**) and musician **102**.

Attachment **108** can be supplied in different sizes accommodating the personal preferences of a person playing instrument **10**.

Fig. 10 (front elevational view) shows instrument **10**, including strings **18** suspended over fingerboard **20** between nut **22** and bridge **24**.

The orientation **114** of bridge **24**, not being perpendicular to longitudinal axis **118** of fingerboard **20**, creates a non-traditional fingerboard topology (imaginary grid of strings **18** and fret system, projected onto fingerboard **20**, as shown in Figs. 12A and 12B). This

fingerboard topology is ergonomically aligned to agree with the natural orientation of the left hand of musician **102** (Fig. 8): the orientation **116** of nut **22** (perpendicular to longitudinal axis **118** of fingerboard **20)** matches the orientation of the musician's hand **110**, as hand **110** approaches nut **22;** the orientation **114** of bridge **24** matches the orientation of the musician's hand **112,** as hand **112** approaches bridge **24**. This fingerboard topology consequently enables ergonomic string crossings for the left hand.

Further, the non-traditional orientation **114** of bridge **24** substantially aligns the points of contact **120** with the normal orientation of bow **106** (perpendicular to longitudinal axis **118** of fingerboard **20)** facilitating more convenient string crossings for the bow arm.

String crossings for both the left arm and bow arm are hence improved elegantly by the non-traditional orientation **114** of bridge **24**.

DESCRIPTION – Alternative Embodiments

Figs. 11A to 11C (front elevational view) show members of the violin family, in particular a violin (or viola) **122**, a cello **124**, and a double bass **126**, all instruments having a non-traditional nut-bridge configuration for ergonomic fingerboard topology and substantial alignment of known points of contact with the orientation of a bow.

Violin **122** (Fig. 11A) shows the non-traditional orientation of the nut **134** substantially aligned with the non-traditional orientation of the bridge **128**, reflecting the almost constant orientation of the left hand (of a violinist) throughout its entire range of motion. The non-traditional orientation of bridge **128** further provides substantial alignment of the points of contact with the orientation of the bow improving string crossings for the bow arm.

Cello **124** (Fig. 11B) shows a non-traditional orientation of the nut **136**, reflecting the orientation of the left arm (of a cellist) when playing close to nut **136** (left hand higher than left elbow). The non-traditional orientation of bridge **130** reflects the orientation of the left arm (of a cellist) when playing close to bridge **130** (left hand lower than left elbow). The non-traditional orientation of bridge **130** further provides substantial alignment of the points of contact with the orientation of the bow improving string crossings for the bow arm.

Double bass **126** (Fig. 11c) shows a non-traditional orientation of the nut **138**, reflecting the orientation of the left arm (of a bassist) when playing close to nut **138** (left hand higher than left elbow). The non-traditional orientation of bridge **132** reflects the orientation of the left arm (of a bassist) when playing close to bridge **132** (left hand lower than left elbow). The non-traditional orientation of bridge **132** further provides substantial alignment of the points of contact with the orientation of the bow improving string crossings for the bow arm.

Figs. 12A and 12B (front elevational view) show two embodiments of a traditional guitar, each having a non-traditional nut-bridge configuration for ergonomic fingerboard topology (here visible by grid of strings and frets), aligned to agree with the natural orientation of the left hand (of a guitarist).

Guitar **140** (Fig. 12A) has a fingerboard topology designed for a classical playing position (fingerboard near vertical). The non-traditional orientation of the nut **144** reflects the orientation of the left arm (of a guitarist) when playing close to nut **144** (left hand higher than left elbow). The non-traditional orientation of the bridge **148** reflects the orientation of the left arm (of a guitarist) when playing close to bridge **148** (left hand lower than left elbow).

Guitar **142** (Fig. 12B) has a fingerboard topology designed for a non-classical playing position (fingerboard near horizontal). The non-traditional orientation of the nut **146** reflects the orientation of the left arm (of a guitarist) when playing close to nut **146** (left hand higher than left elbow). The non-traditional orientation of the bridge **150** reflects the orientation of the left arm (of a guitarist) when playing close to bridge **150** (left hand lower than left elbow).

Fig. 13 (perspective view) shows body **12** of instrument **10** supported at second end **16** by a conventional endpin structure **152** positioned on the median plane of musician **102**; first end **14** rests at the sternum (median plane) of musician **102**. Instrument **10** is thus located on the median plane of musician **102**, allowing a basic playing position with ergonomic advantages as described in detail in Fig. 8 and Fig. 10. However, the static (non-pivoting) interface between instrument **10** and endpin structure **152** – facilitating only a floor-based pivot for instrument **10** - prevents the described congruent movement of instrument **10** and the torso of musician **102** (Fig. 8). Further, said floor-based pivot (ball joint type) forces musician **102** to stabilize instrument **10**, hence restricting the freedom of motion of musician **102**.

Thus the combination of endpin structure **152** and instrument **10**, utilizing only some of the claims of this invention, is not preferred.

Fig. 14 (perspective view) shows body **12** of instrument **10** supported at second end **16** by a tripod **154** (floor-based), tripod **154** including gimbal system **58** for interfacing with second end **16**; first end **14** rests at the sternum (median plane) of musician **102**. Tripod **154** enables gimbal system **58** to be positioned (relative to torso of musician **102**) as described in Fig. 8. Although being a viable embodiment, the combination of tripod **154** and instrument **10** is not a preferred embodiment: tripod **154** is not linked structurally to chair **104**; thus, precise adjustments are required to attain and maintain the relative position between tripod **154** and the seat of chair **104**, further preventing the use of a swivel chair.

Fig. 15 (perspective view) shows an acoustic embodiment **156** of instrument **10** used in combination with support **60**. The first end **160** of the body **162** of acoustic embodiment **156** rests at the sternum of musician **102**; the second end **158** of body **162** interfaces with support **60** at gimbal system **58**. Fig. 15 thus shows a viable embodiment of this invention, offering the ergonomic benefits as described in Fig. 8 and Fig. 10.

Fig. 16 (perspective view) shows a conventional electric cello **164** (shown here with non-traditional nut-bridge configuration as described in Fig. 10) used in combination with support **60**. A second end **168** of the body **172** of electric cello **164** interfaces with support **60** at gimbal system **58**; body **172** is further supported at the sternum of musician **102** by a conventional chest support **170**, a first end **166** of body **172** located above the shoulder of musician **102**. While congruent movement between electric cello **164** and the torso of musician **102** is facilitated by support **60**, body **172** of electric cello **164** can not be positioned on the median plane of musician **102**.

Thus support **60** offers ergonomic benefits in playing a conventional electric cello such as electric cello **164**.

Fig. 17 (perspective view) shows a keyboard **174** used in combination with support **60**. A first end **176** of the body **178** of keyboard **174** rests at the sternum of musician **102**; a second end **180** of body **178** interfaces with support **60** at gimbal system **58**. Keyboard **174** is positioned on the median plane of musician **102** and can thus move congruently with the torso of musician **102** via gimbal system **58** of support **60**.

Thus the combination of keyboard **174** and support **60** offers many of the ergonomic benefits described in Fig. 8.

Fig. 18 (perspective view) shows a wind instrument **182** used in combination with support **60**. A first end **184** of the body **186** of wind instrument **182** rests at the sternum of musician **102**; a second end **188** of body **186** interfaces with support **60** at gimbal system **58**. Wind instrument **182** is positioned on the median plane of musician **102** and can thus move congruently with the torso of musician **102** via gimbal system **58** of support **60**.

Thus the combination of wind instrument **182** and support **60** offers many of the ergonomic benefits described in Fig. 8.

Fig. 19 (perspective view) shows instrument **10** used with a first alternative support **190** having a support member **192** of a torsion-bar design. Support **190** includes a living hinge **194** interfacing with second end **16** of body **12** of instrument **10**. Living hinge **194** enables rotation of body **12** around a first axis **196** defined by living hinge **194**. Support member **192**, being of a torsion-bar design, enables instrument **10** to rotate around a second axis **198** identical with the longitudinal axis of support member **192**; support member **192** further enables spring-like reversion of instrument **10** to its original position.

Alternative support **190** thus provides a viable alternative to support **60** of Fig. 5A, adding the torsion-bar design's advantage of spring-like reversion of instrument **10** to its original position. Living hinge **194** provides a smooth rotation around axis **196**.

Fig. 20 (perspective view) shows instrument **10** used with a second alternative support **200** having a support member **202** and a universal joint **204** interfacing with second end **16** of body **12** of instrument **10**. Universal joint **204** enables rotation of instrument **10** around two axes, first axis **206** and second axis **208**, both axes perpendicular to each other, while preventing rotation of instrument **10** around its longitudinal axis **92** (not shown here). Thus second alternative support **200** provides a viable alternative to support **60** of Fig. 5A.

Fig. 21 (perspective view) shows instrument **10** used with a third alternative support **210** consisting of two support rods **212** (generally indicated) having two endpoints **218**; rods **212** partially inserted into two corresponding bores **214** in a seat **216**, the protrusion of rods **212** being adjustable. Rods **212** act as both pincers to grip second end **16** of body **12** and pivots, at endpoints **218**, for rotation of instrument **10** around a first axis **220** defined by endpoints **218**.

While rods **212** are stiff enough to support instrument **10**, they allow bending sufficient to enable rotation of instrument **10** around a second axis **222** identical with the longitudinal axis of support **210**.

Thus third alternative support **210** provides a viable alternative to support **60** of Fig. 5A.

Fig. 22 (perspective view) shows a fourth alternative support **224** used with a traditional music stand **226**. Support **224** comprises a support member **228**, a mounting system **230** for interfacing with stand **226**, and gimbal system **58**. While support **224** is height adjustable it is stationary relative to stand **226**, and thus impractical for use with a

swivel chair. A chair-based instrument support as shown in Fig. 5A is inherently more stable than support **224** used with stand **226**, and thus fourth alternative support **224**, although a viable alternative to support **60**, is less desirable.

Fig. 23 (perspective view) shows a highly portable fifth alternative support **232** that can be used with any flat surface. Support **232** comprises puck-like base **234** housing gimbal system **58**, and thus offers all ergonomic benefits when having gimbal system **58** positioned relative to musician **102** (not shown here) as described in Fig. 8. Although highly portable and stable, fifth alternative support **232** is impractical for use with a swivel chair.

Fig. 24 (perspective view) shows an alternative way of interfacing support **60** with seat **216**, having support member **62** inserted into a slot **236** in seat **216**. While the protrusion of support **60** is adjustable, the interface between support **60** and seat **216** is secured by friction when support **60** interfaces with instrument **10** (not shown here). Thus the here described interface provides a more convenient alternative to having support member **62** supported on top of seat **216** and held in place by musician **102** (not shown here).

Fig. 25 (perspective view) shows an alternative way of interfacing support **60** with seat **216**, using a first mount **238** screwed to bottom of seat **216** via screws (not numbered). Similar to the description in Fig. 24 the protrusion of support **60** is adjustable and the interface between support **60** and seat **216** is secured by friction when support **60** interfaces with instrument **10** (not shown here).

Thus the here-described interface provides another more convenient alternative to having support member **62** supported on top of seat **216** and held in place by musician **102** (not shown here).

Fig. 26 (perspective view) shows a sixth alternative support **240** comprising a telescopic support member **242,** screwed to bottom of seat **216** via screws (not numbered), and gimbal system **58**. Support member **242** enables protrusion adjustment from seat **216** including complete retraction.

Fig. 27 (perspective view) shows a seventh alternative support **244** comprising a curved support member **246** for use with person wearing a skirt. Support **244** is attached to seat **216** via second mount **248**. While offering described advantage support **244** does not offer protrusion adjustment from seat **216**.

Fig. 28 (perspective view) shows an eighth alternative support **250** comprising a two-segment support member **252**, segments pivotally connected by a pin **254**, and a modified gimbal system **256**. The function of median ring **68** of Fig. 5A is performed by support member **252**, and thus median ring **68** is omitted at modified gimbal system **256**. Support **250** is mounted to seat **216** via second mount **248**.

Fig. 29 (perspective view) shows a ninth alternative support **258** comprising a two-segment support member **260**, segments connected by a hinge **262**, and gimbal system **58**. Hinge **262** comprises locking mechanism for keeping both segments of support member **260** aligned during, and enables folding of support member **260** for space economy after, operation. Similar to Fig. 24 support **258** interfaces with seat **216** via slot **236**.

Figs. 30A (perspective view), 30B (side elevational view), and 30C (top plane view) show a small simplified instrument-support unit **264** having a simplified instrument **266** permanently connected to a simplified support **268** by a hinge **270**, instrument **266** having two strings **272** and a fretted fingerboard **274** for use by a child **276**. Hinge **270** enables both rotation of instrument **266** relative to support **268** for adjustment to the

chest (not numbered) of child **276**, and collapse (shown in phantom lines) of unit **264** for ease of handling. The bottom of support **268** is slightly convex (not shown) enabling instrument **266** to slightly pivot, congruently with the swaying torso motion of child **276**.

DESCRIPTION – Preferred Embodiment II

Figs. 31A (front elevational view), 31B (side elevational view), and 31C (back elevational view) show an instrument **278** (generally indicated), being an alternative embodiment of instrument **10** of Fig. 1A. Instrument **278** comprises a body **280** made of aluminum alloy, a fingerboard **282** made of UHMW (ultra high molecular weight polypropylene), and an insert **284** (shown in more detail in Figs.32A and 32B) made of aluminum alloy, all connected magnetically (shown in detail in Figs 33A to 33D). Body **280** includes an economized head design **286** for receiving a set of bass guitar tuners **288**, a cavity **290** (partially concealed by insert **284**) for receiving insert **284**, a slot **292** for receiving bridge **24**, and a set of four holes **294** for receiving strings **18**.

Insert **284** houses jack **36** and a potentiometer **296**; insert **284** further includes a cavity **298** for interfacing with a support **300** (shown in Figs. 34A and 34B).

Strings **18** are suspended over fingerboard **282** by nut **22** and bridge **24** having a non-traditional orientation; strings **18** are held in tension by anchoring at holes **294** and tuners **288**. Fig. 31C further shows the location of thin disc magnets **302** (shown in detail in Fig. 33A) used for connecting fingerboard **282** to body **280**.

Figs. 32A (top perspective view) and 32B (bottom perspective view) show insert **284** housing potentiometer **296** and jack **36**; further shown is a complex cavity system **304** for housing wires (not shown) and for mounting of both jack **36** and potentiometer **296**. Thick disc magnets **306** are held, by press fit, in holes (not numbered) close to cavity **298**.

Figs. 33A (exploded view), 33B (enlarged view), 33C (enlarged view), and 33D (side view) show the assembly of body **280**, fingerboard **282**, and insert **284** via thin disc magnets **302** and thick disc magnets **306**. Both fingerboard **282** and nut **22** are aligned with body **280** by ball bearings **308** semi recessed into body **280** and held by mini disc

magnets **310**. The protruding hemispheres of bearings **308** fit into hemispherical recesses **312** in fingerboard **282** and nut **22** as shown in detail in Fig. 33D. Magnets **302**, magnets **306**, and magnets **310** are mounted via press fit.

Figs. 34A and 34B (both perspective views) show support **300** comprising a support member **314** and a ferrous metal cylinder **316** for both interfacing with cavity **298** and for rotating instrument **278** around longitudinal axis **318** of cylinder **316**; magnets **306** and ferrous metal cylinder **316** maintain the interface between support member **314** and instrument **278**. Support member **314** is of a torsion bar design, thus allowing rotation of instrument **278** around longitudinal axis **320** of support member **314**, and enabling spring-like reversion of instrument **278** to its original position. The system of instrument **278** and support **300** can collapse for ease of handling.

Figs. 35A and 35B (both perspective views) show support **322** comprising support member **314** and a living hinge **324** having a tongue **326** for interfacing with groove **328** of modified insert **330**. Living hinge **324** provides axis **332** for rotation of instrument **278**. The interface between instrument **278** and support **322** is securely engaged when tongue **326** of living hinge **324** is bent upwards; the interface between instrument **278** and support **322** can be disengaged by relaxing living hinge **324** or bending tongue **326** downwards.

Support member **314** is of a torsion bar design, thus allowing rotation of instrument **278** around longitudinal axis **320** of support member **314**, and enabling spring-like reversion of instrument **278** to its original position. The system of instrument **278** and support **322** can collapse for ease of handling.

Fig. 36 (perspective view) shows a seated musician **102** playing instrument **278**. Instrument **278** magnetically interfaces with support **300** via cylinder **316** (shown in Figs. 34A and 34B); thus musician **102** can adjust instrument **278**, its longitudinal axis **334**

being on anatomical median plane **96** (shown in Fig. 7), for comfortably interfacing with the sternum via economized head design **286**. Tuners **288** are located for comfortable tuning for the left hand of musician **102**. Both nut **22** and bridge **24** are positioned providing a comfortable workspace for the left arm and bow arm of musician **102**; both the distance between nut **22** and bridge **24**, being greater than that of a viola and lesser than that of a cello, as well as the economized head design **286**, reducing the distance between nut **22** and sternum during interface, enable the described ergonomic positioning of instrument **278**.

Support member **314**, interfacing with chair **104** provides longitudinal axis **320** for rotation of instrument **278** congruently (described in more detail in Fig. 8) with the torso of musician **102**, further enabling spring-like reversion of instrument **278** via torsion-bar design. The interface between instrument **278** and support **300** further resists rotation around longitudinal axis **320**, enabling freedom of motion for the legs of musician **102**.

Advantages of instrument **278** further include modular fingerboard **282** for both simplifying the assembly process and enabling convenient interchange of either instrument **278** or fingerboard **282**, as well as bridge **24** having a non-traditional orientation for both providing a more ergonomic fingerboard topology and for aligning known points of contact **120** (shown in Fig.10).

Fig. 37 (perspective view) shows musician **102** standing and playing instrument **278**, held by a support (not shown or numbered) close to the waist. Instrument **278** is positioned on anatomical median plane **96** (not shown) of musician **102** and able to move congruently with the swaying torso of musician **102**, the position of instrument **278** being a function of the position of the musician's torso; while offering the ergonomic benefits described in Fig. 8 and Fig. 36, the entire weight of instrument **278** must be supported by musician **102** in Fig. 37.

All of the foregoing descriptions show the many components of the present invention. While each component has its special function in the entire system, and also offers advantages when used by itself, all components complement each other synergistically.

While the above description contains many specificities, these should not be construed as limitations on the scope of the invention, but rather as an exemplification of preferred embodiments thereof.

DESCRIPTION – Ramifications

The instrument

(a) can be electric or acoustic

(b) can be of different shape

(c) can be made using other materials

(d) can include a wireless transmitter

(e) can be fitted with a sensory fingerboard for omission of strings

(f) can be fitted with additional features such as a preamp, head phone jack, speakers, and lights

(g) can be fitted with a fretted fingerboard

(h) can have a fingerboard with fingering guide

(i) can include different accessories for further improving

(j) can have different tuning devices such as standard pegs and fine tuners

(k) can have different number of strings

(l) can be a plucked instrument

(m) can have different locations for some of the described parts such as jack, potentiometer, and string mount.

The support

(a) can be made using different materials

(b) can be of different shape

(c) can be fitted with additional attachments such as pencil holder, cable mount, and instrument snap-on

(d) can include a handle

(e) can house elements such as a preamp, speakers, and head phone jack

(f) can include a compartment for storing a bow.

The interface between the instrument and the support

(a) can be permanent

(b) can be fitted with additional spring systems

(c) can utilize a different way of achieving the desired means for pivoting, such as mounting a gimbal system onto instrument.

The interface between support and chair

(a) can be permanent

(b) can be such that the support is integrated into chair

(c) can include a simple locking mechanism such as snap-on or bayonet mount.

Accordingly, the scope of the invention should be determined not by the embodiments illustrated, but by the appended claims and their legal equivalents.